First record of *Akera* Müller, 1776, from the eastern Pacific, with the description of a new species

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ABSTRACT

The description of the new species *Akera julieae* is based on a complete specimen collected from southern California and three empty shells from Costa Rica. These specimens constitute the first record of *Akera* in the eastern Pacific. *Akera julieae* is distinguishable from the widespread Indo-Pacific species *Akera soluta* by its radular and jaw morphology; the rachidian teeth of *A. soluta* are more solid with larger cusps and flanking denticles, the mid-lateral teeth of *A. soluta* are denticulated, whereas in *A. julieae* they are smooth, and the outermost lateral teeth of *A. julieae* are proportionally more elongate and straighter than those of *A. soluta*; the jaws of *A. soluta* are well developed and composed of a number of rows of strong rodlets, whereas in *A. julieae* the jaws are more rudimentary with only five rows of fragile-looking rodlets. There are no consistent differences between these two species in gizzard plate and adult shell morphology, but the protoconch of *A. soluta* is slightly larger and more elongate. The western Atlantic species *Akera bayeri* is distinguishable from *A. julieae* by having a more elevated shell spire and stronger radular teeth with denticles on all lateral teeth.

INTRODUCTION

The opisthobranch family Akeridae Mazzarelli, 1891, includes opisthobranchs with an external, cylindrical shell into which the animal cannot retract completely. It contains the single genus *Akera* Müller, 1776, and only a few Recent valid species distributed throughout tropical and temperate regions. The type species, *Akera bullata* Müller, 1776, has been reported from the northeast Atlantic, from the Baltic shores of Denmark and Norway to the British Isles, continuing on to the Atlantic and Mediterranean costs of continental France and Spain (Thompson, 1976), Italy (Rinaldi, 1988), and the Canary Islands (Ortea et al., 2001).

In the Indo-Pacific, the widespread species *Akera soluta* (Gmelin, 1791) has been reported from South Africa and Mozambique to Australia, Marshall Islands, and the Philippines (Gosliner, 1987). Both *Akera bicincta* (Quoy and Gaimard, 1833), from Australia, and *Akera constricta* Kuroda 1947, from Japan, have been regarded as junior synonyms of *A. soluta*, see Wells and Bryce (1993) and Hamatani (2000) respectively. This expands the known range for *A. soluta*. Other nominal Indo-Pacific species, *Akera tumida* (A. Adams in Sowerby, 1850), *Akera tasmanica* Beddome, 1882, and *Akera aperta* Hedley, 1899, were all described from the southwestern Pacific, and are poorly known. They are likely synonyms of *A. soluta*, but because they were described based solely on shell morphology, their identities are unclear and in need of revision. In the western Atlantic, Olsson and McGinty (1951) reported for the first time a species of *Akera* from Florida under the name "Akera thompsoni." Because the animal was figured but not described, this species name is a *nomen nudum* in accordance with Article 13.1 of the International Code of Zoological Nomenclature (ICZN, 1999). The first available name for the western Atlantic *Akera* is *Akera bayeri* Ev. Marcus and Er. Marcus, 1967, which has been reported from the southwestern Caribbean Sea and Brazil (Ev. Marcus, 1970).

There are no Recent species of *Akera* known from the eastern Pacific. *Akera maga* Vokes, 1939, the only known species from this area, was described from the lower to middle Eocene, Domengine Formation, Fresno County, California (Vokes, 1939). Squires (2001) reported this species from the Llajas Formation (also lower to middle Eocene), Ventura County, California. In the present paper we describe the first occurrence of Recent *Akera* in the eastern Pacific based on a complete specimen collected in the Channel Islands, California and three shells from Guanacaste, Costa Rica.

MATERIALS AND METHODS

The specimen from California was collected as part of the Southern California Bight 1998 Regional Marine Monitoring Survey (Bight, 1998) conducted in the summer of 1998. Infaunal samples were taken with a 0.1 m^2 Van Veen grab sampler and screened through a 1 mm mesh. The sample was then placed in a relaxant solution of Epsom salts (magnesium sulfate heptahydrate—

Table 1. Comparative material examined in this study. The specimen marked with an asterisk (*) was collected alive and included soft parts.

Species	Locality	Date	Depth	Number
Akera soluta	Kii, Japan	—		LACM 153414*
	Uala Reef, Quezon, Philippines	May 1959	3–15 m	LACM 073035
	New Zealand	—	—	LACM 153415
	Hardwick Bay, South Australia	—	—	LACM 157942
	Hardwick Bay, South Australia	—	—	LACM 153416
	Hardwick Bay, South Australia	—	—	LACM 153417
	Phuket, Thailand	—	—	LACM 046386
Akera bullata	Finmark, Norway	—	—	LACM 153418

$MgSO_4 \cdot 7H_2O$) and freshwater for a minimum of 30 minutes. The sample was then fixed in 10% buffered formalin and preserved in 70% ethanol. The preserved whole animal was photographed using a digital camera mounted on a dissecting scope (Wild Epimarkroskop® M450).

The Costa Rican shells were collected during the Searcher 401 Expedition of the Natural History Museum of Los Angeles County.

Several additional specimens and shells belonging to other species of *Akera* were examined for comparison purposes. These specimens are listed in Table 1.

The shell is very fragile and could not be dissected intact from the specimens examined, which rendered the description below incomplete. Once the shell was removed, the internal organs were dissected and drawn using a Nikon SMZ 1000 microscope equipped with a drawing tube. The radula, jaws, and gizzard plates were dissected and photographed using a Hitachi S-3000N Scanning Electron Microscope (SEM). The apical region of the shell was separated from the rest of the shell and mounted for SEM photography.

SYSTEMATICS

Akeridae Mazzarelli, 1891
Akera Müller, 1776

Type Species: *Akera bullata* Müller, 1776, by monotypy.

Diagnosis: Shell external, fragile, translucent, cylindrical to slightly bulloid. Spire flattened to elevated with a partially embedded protoconch. Aperture equal to the length of the spire or slightly shorter. Thin periostracum forming a raised flange at the keel. Animal unable to retract fully into the shell, but can stretch over twice its length; with a posterior pallial tentacle. Parapodia extending laterally, meeting mid-dorsally over the shell. Radula with rachidian tooth having a median cusp and smaller denticles on either side. Rachidian tooth flanked by 21–52 lateral teeth. Gizzard with a number of irregular plates arranged in three tiers.

Akera julieae new species
(Figures 1–4)

Akera sp.—Behrens, 2004: 18, pl. 1D.

Holotype: LACM 3033, from type locality.

Paratypes: 3 shells, southeastern corner of Bahía Jobo, off sand beach west of Bahía de Salinas, Guanacaste Province, Costa Rica (11°02′22″ N, 85°45′16″ W), 14 Feb. 1972, 1.5–10.7 m depth (LACM 3034).

Type Locality: Southwestern corner of Santa Catalina Island, California, USA (33°18′24″ N, 118°22′05″ W), 24 Jul. 1998, 40.6 m depth, in gray colored silt and clay (LACM 3033).

External Morphology: The body is oval, 10 mm long in the preserved holotype. The cephalic shield is triangular, comprising about ¼ of the body length in the preserved specimen (Figures 1A, 2A). The parapodia are narrow and do not reach the midline of the body (Figures 1A–C, 2A). The gill is unipinnate, with 11 simple lamellae (Figure 2B). The color of the living animals is unknown; the preserved holotype is grayish white.

Shell Morphology: The shell is bullomorph, fragile, well-calcified (Figure 1). The protoconch is smooth, and only the outer whorl is visible externally (Figure 3C). Its maximum diameter is 200 µm. The whorls are separated by a deep, channelled suture, which is shallower on the apical whorls. The periphery of the whorls, near the apex, is angulated and forms a conspicuous keel, which divides the whorls into two parts (Figure 1D, 3C). The inner part has a characteristic pattern of strong, curved wrinkles. The whorls are attached to the preceding whorl just below the periphery of this whorl. The apical region is flattened and the external whorls overlap the most internal. The whorl sides are clearly curved, convex. The aperture is broad below and narrow above, where it extends into a deep sinus along the suture of the upper lip. There is a thin callus in the columella. The sculpture consists of numerous, low and thin spiral ribs and axial growth lines. The shells are covered with a thin brownish periostracum.

Anatomy: The buccal bulb is oval; it connects posteriorly to the long esophagus and the salivary glands (Fig-

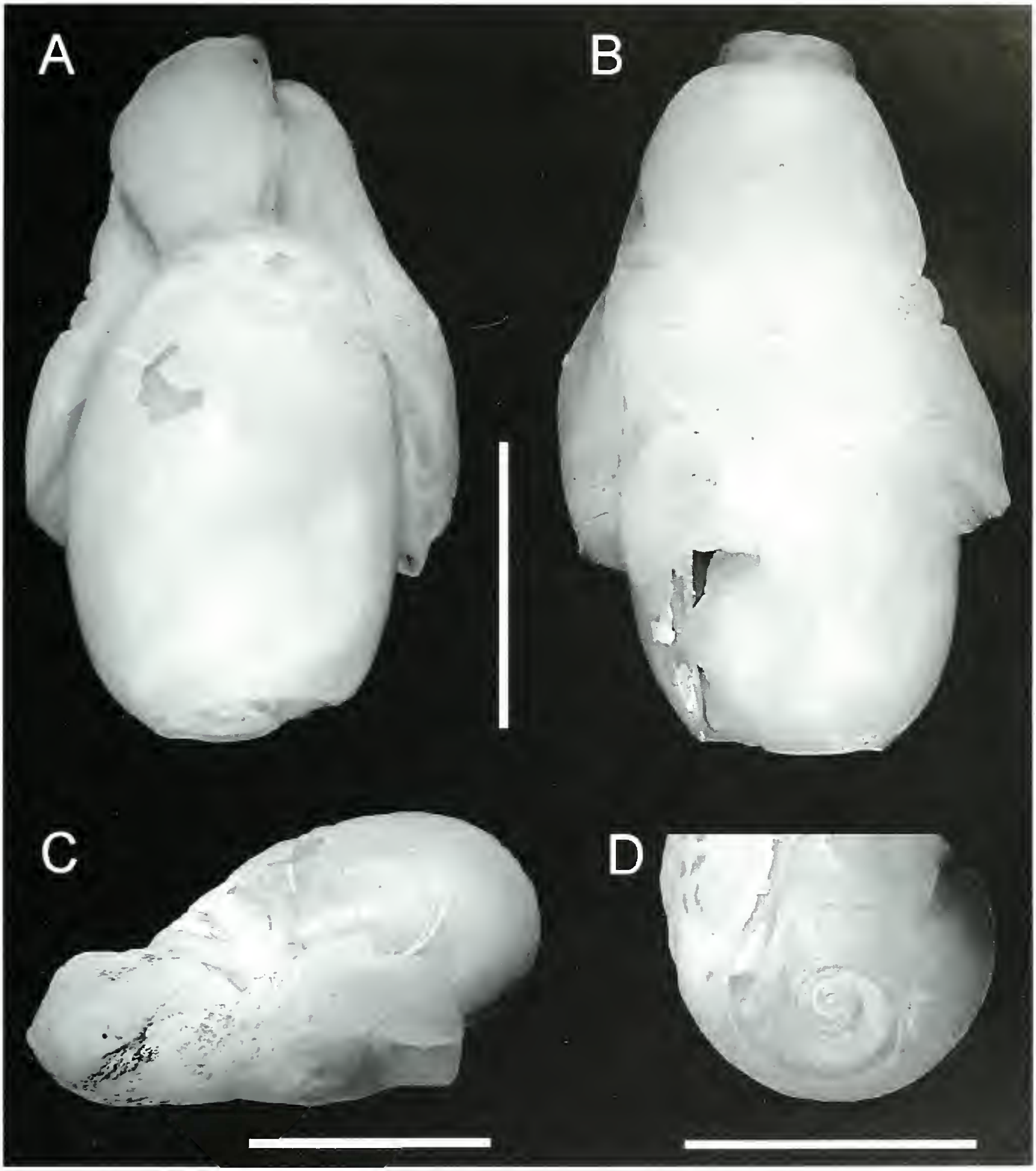

Figure 1. *Akera julieae* new species, photographs of the preserved holotype (LACM 3033). **A.** Dorsal view. Scale bar = 5 mm. **B.** Ventral view. Scale bar as in A. **C.** Lateral view. Scale bar = 5 mm. **D.** Apical view of the shell. Scale bar = 5 mm.

ure 2C). Two strong retractor muscles attach laterally to the buccal bulb. The radular formula is 19×23.1.23 in the holotype. The rachidian teeth are broad, with a triangular based, basally concave, and a pointed central cusp (Figure 4A). There are 3–5 denticles on each side of the cusp varying in shape and size. The two innermost teeth on each row have a long and narrow base and a conspicuously wider cusp bearing denticles on the inner

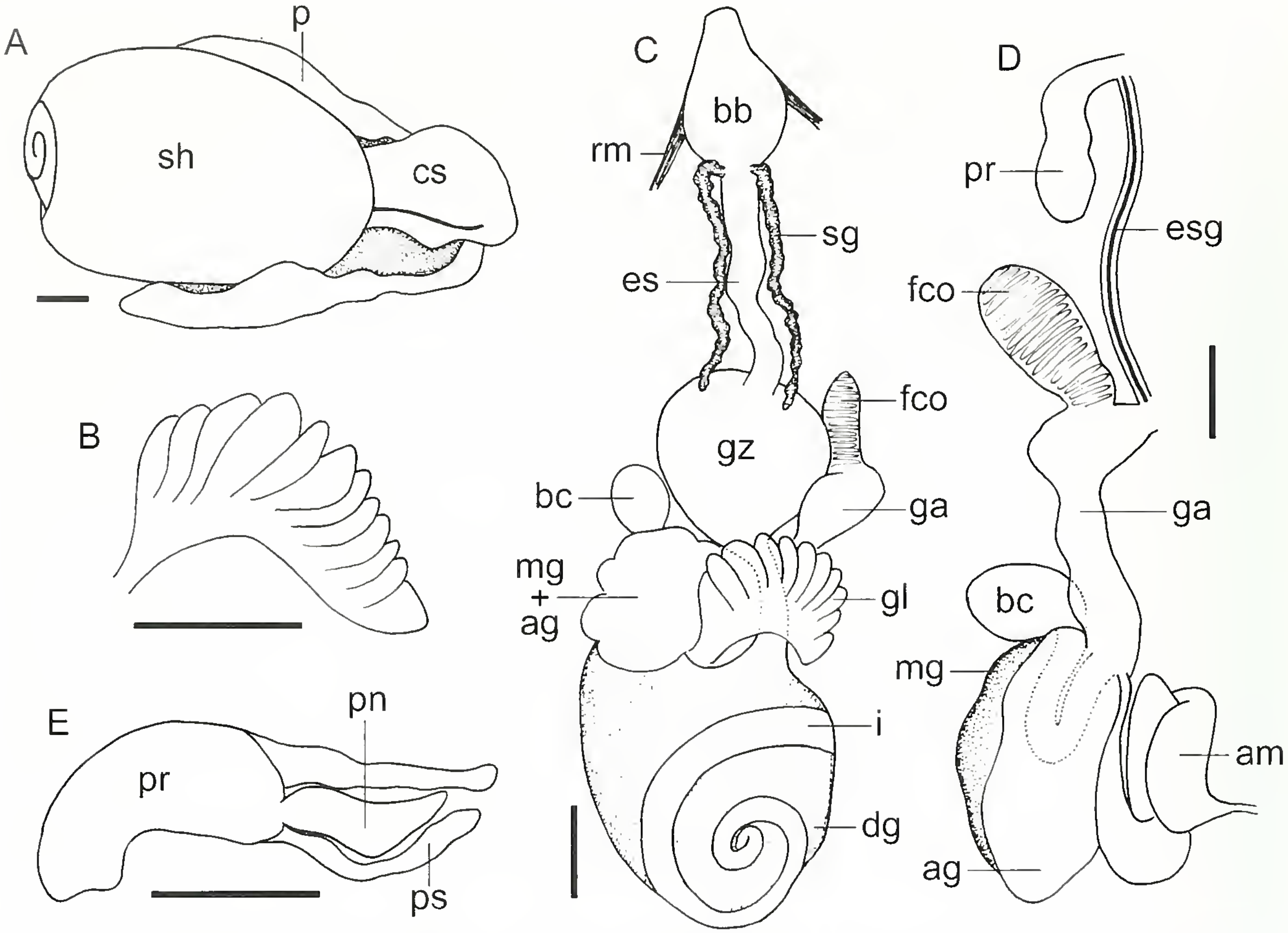

Figure 2. *Akera julieae* new species, drawings of the preserved holotype (LACM 3033). **A.** Dorsal view of the complete body. Scale bar = 1 mm. **B.** Detail of the gill. Scale bar = 1 mm. **C.** General view of the anatomy. Scale bar = 1 mm. **D.** General view of the reproductive system. Scale bar = 0.5 mm. **E.** Penis and prosate. Scale bar = 0.5 mm. Abbreviations: ag, albumen gland; am, ampulla; bb, buccal bulb; bc, bursa copulatrix; cs, cephalic shield; dg, digestive gland; es, esophagus; esg, external seminal groove; fco, female copulatory organ; ga, genital atrium; gl, gill; gz, gizzard; i, intestine; mg, mucous gland; pn, penis; pr, prostate; ps, penial sheath; rm, retractor muscle; sh, shell; sg, salivary gland; sr, seminal receptacle.

and outer sides. The rest of the lateral teeth are hook-shaped, with a long and narrow cusp and lack denticles (Figure 4B). In the outermost teeth the base is shorter and the cusp proportionally longer than in the mid-laterals (Figure 4C). The jaws are composed of 6 rows of simple, elongate rodlets (Figure 3B). The esophagus opens into a large muscular gizzard, which contains several gizzard plates. The gizzard plates vary in shape and size; they are irregular with angular edges (Figure 3A).

The reproductive system is monoaulic (Figure 2D). The ampulla is long and convoluted; it opens into the genital atrium at the same point where the albumen and mucous glands open. The bursa copulatrix is oval; it connects with the genital atrium through a wide and curved duct. The genital atrium is long and is connected to a complex female copulatory organ near the opening. From the gonopore an open seminal groove runs in anterior direction to the protrusible cephalic penis and the prostate. The penis is long and externally enclosed in a sheath (Figure 2E). The prostate is short and simple, and connects proximally to the penis.

Etymology: Dedicated to Julie Barwick, the daughter of the junior author.

DISCUSSION

Akera julieae has been included in *Akera* because of the presence of a fragile, cylindrical external shell, a flattened spire, and a partially embedded protoconch. The radula of this species has a single broad, triangular rachidian tooth, with a median cusp and smaller denticles on either side, as well as several hamate lateral teeth. The gizzard contains a number of irregular gizzard plates arranged in three tiers. All these characteristics are diagnostic of the genus *Akera* (see above).

This is the first record of *Akera* in the eastern Pacific. Behrens (2004) cited this species as *Akera* sp., based on

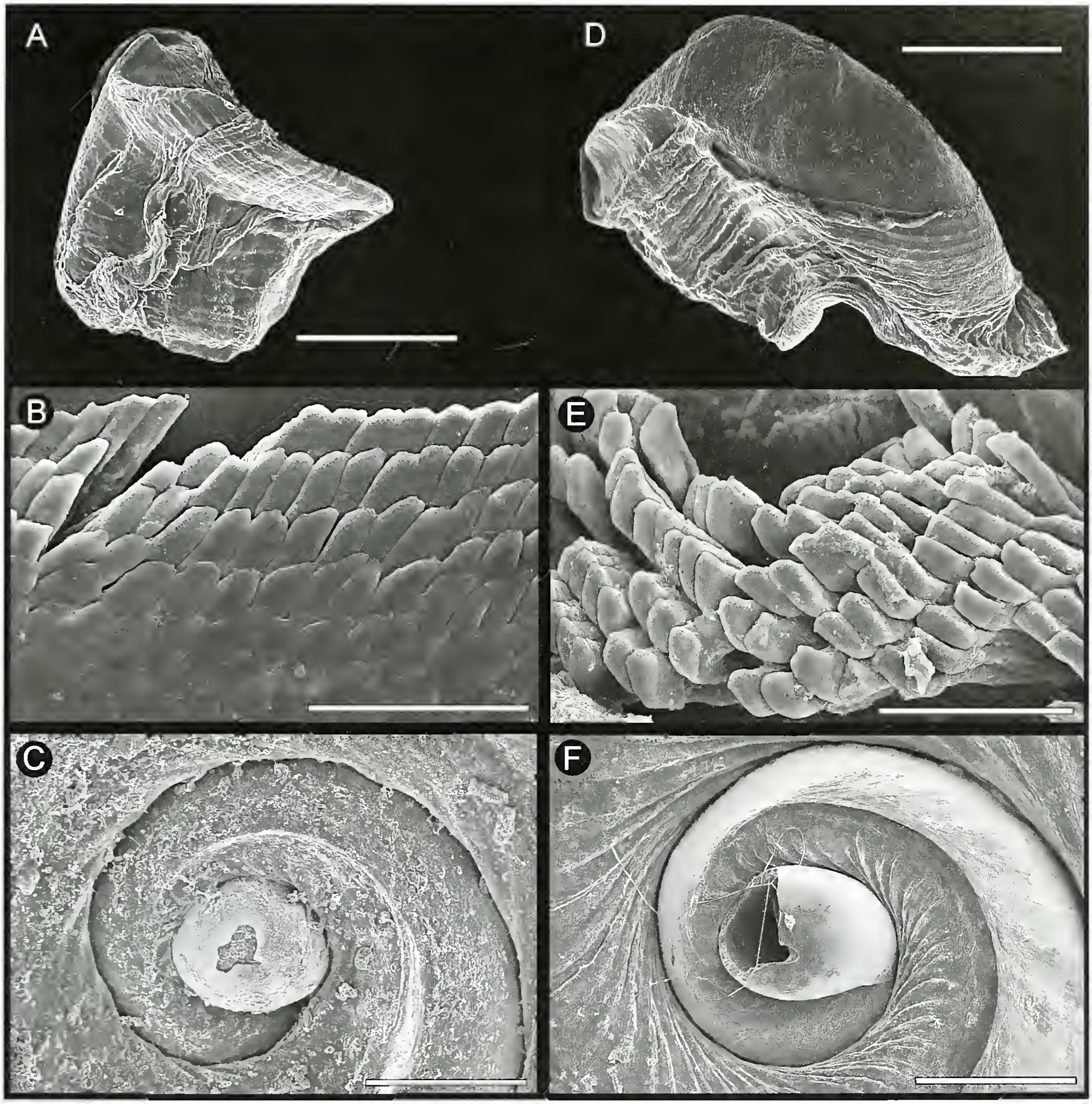

Figure 3. *Akera juliae* new species and *A. soluta* (Gmelin, 1791). **A–C.** *Akera julieae*, scanning electron micrographs of the preserved holotype (LACM 3033). **A.** Gizzard plate. Scale bar = 300 μm. **B.** Jaw. Scale bar = 50 μm. **C.** Protoconch. Scale bar = 200 μm. **D–E.** *Akera soluta* (Gmelin, 1791), scanning electron micrographs of a specimen from Japan (LACM 153414). **D.** Gizzard plate. Scale bar = 300 μm. **E.** Jaw. Scale bar = 50 μm. **F.** Protoconch. Scale bar = 200 μm.

the material here examined and information, photographs, and descriptions provided by the junior author. The description of the new species is mainly based on the holotype, collected from California, but the three empty shells collected from Costa Rica seem to belong to the same species. However, this needs to be verified when complete specimens from Costa Rica become available.

Akera julieae differs from other described species of the genus. Several shells and one specimen of the Indo-Pacific *Akera soluta* were examined for comparison (see Table 1) confirming the presence of several external and internal differences between these two species. For instance, the rachidian radular teeth of *A. soluta* are more solid with larger cusps and flanking denticles (Figure 4D). The three innermost lateral teeth have wide cusps

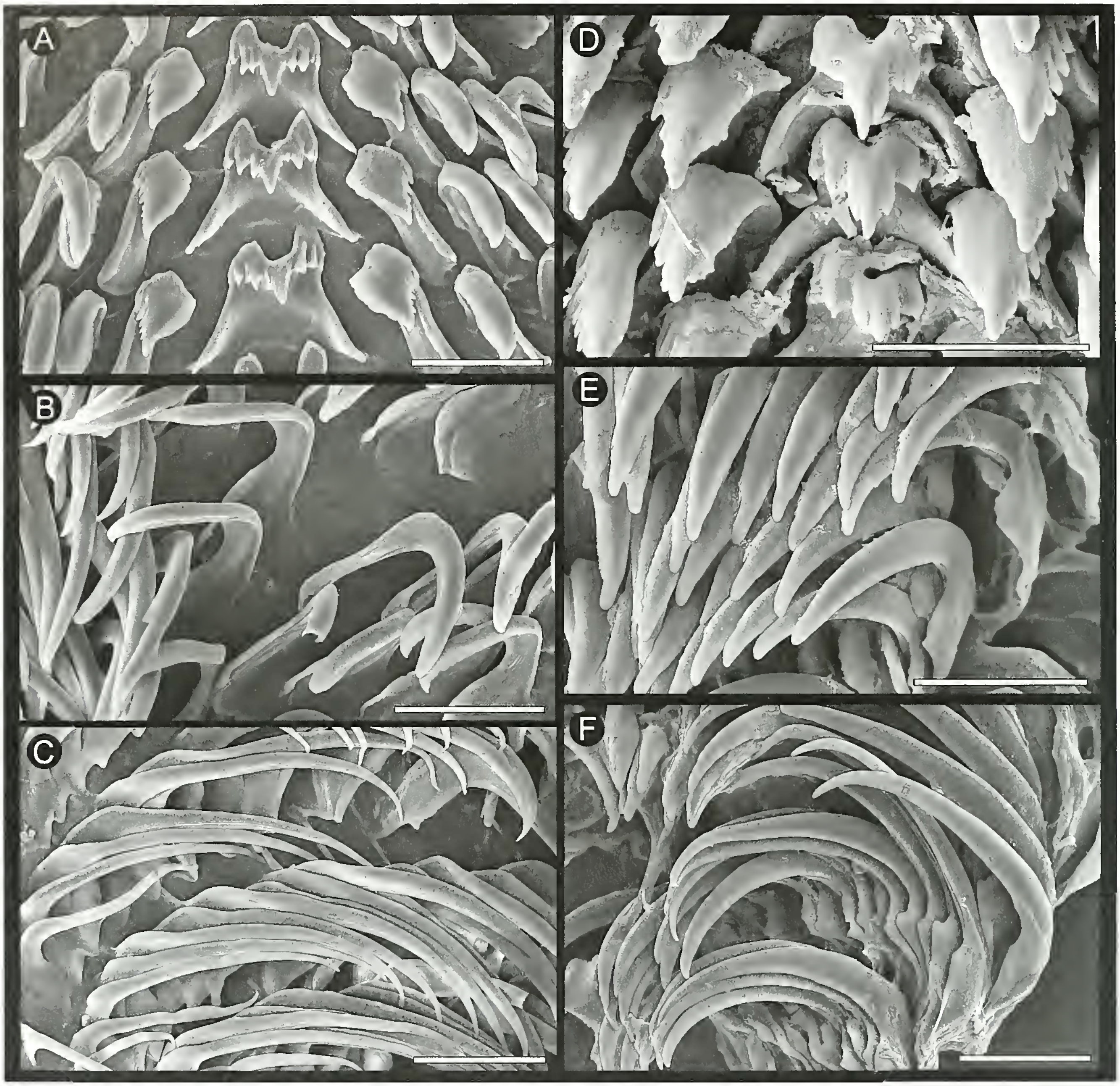

Figure 4. *Akera juliae* new species and *A. soluta* (Gmelin, 1791). **A–C.** *Akera julieae*, scanning electron micrographs of the radula of the holotype (LACM 3033). **A.** Rachidian and innermost lateral teeth. Scale bar = 50 μm. **B.** Mid-lateral teeth. Scale bar = 50 μm. **C.** Outermost lateral teeth. Scale bar = 50 μm. **D–F.** *Akera soluta*, scanning electron micrographs of the radula of a specimen from Japan (LACM 153414). **D.** Rachidian and innermost lateral teeth. Scale bar = 50 μm. **E.** Mid-lateral teeth. Scale bar = 50 μm. **F.** Outermost lateral teeth. Scale bar = 50 μm.

with denticles in *A. soluta*, whereas only the two innermost teeth of *A. julieae* have similar characteristics. The mid-lateral teeth in *A. soluta* also have denticles (Figure 4E), whereas they are smooth in *A. julieae*. The outermost lateral teeth of *A. julieae* are proportionally more elongate and straighter than those of *A. soluta* (Figure 4F). More importantly, the jaws of *A. soluta* are well developed and composed of a number of rows of strong rodlets (Figure 3E), whereas in *A. julieae* the jaws are more rudimentary with only 5 rows of fragile-looking rodlets. There are no consistent differences between the gizzard plates of *A. julieae* and *A. soluta* (Figures 3A, 3D). Externally, *A. soluta* has a slightly larger and more elongate protoconch. The adult shells of these two species are indistinguishable due to the morphological variability in *A. soluta*.

Akera bayeri is the only other species of *Akera* known from the Americas. The external morphology and anatomy of this species was described in detail by Marcus and Marcus (1967) and Marcus (1970). *Akera bayeri* differs from *A. julieae* in two important regards. The shell of *A. bayeri* has a more elevated spire and the radular teeth are stronger with denticles on all lateral teeth, whereas in *A. julieae* the lateral teeth are smooth.

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